

## Automated Biological Sample Processing: MAPS

### Need

In today's laboratories, biological-sample processing is a major bottleneck, consuming more than 60% of the total time needed to analyze and characterize samples completely. There are multiple challenges when processing samples. For example, most separation and detection methods have strict sample-preparation constraints. Further, every biological system needs a customized sample-processing protocol that comprises laborious, complex operations. Manual processing requires trained staff, and the many steps involved both increase costs and elevate the risk of introducing errors. In addition, because of the size and cost of the equipment used, modifying an analysis train is expensive and difficult.

### Solution

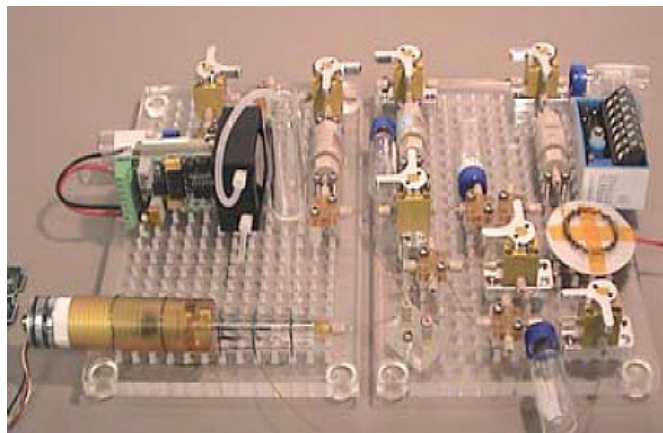
Drawing on our strengths in integrated systems and the emerging field of microfluidics, Sandia National Laboratories is developing modular, automated processing systems (MAPS) for constructing continuous protocols that can be tailored to any biological application:

- Fractionation, filtering, and sieving
- Protein enrichment or depletion (ion exchange; hydrophobic, affinity-based interactions)
- Capture and concentration of viruses, spores, and cells
- Cell lysate cleanup
- Thermal and chemical lysis
- Desalting, buffer exchange, and the removal of interferent species by using size exclusion
- Enzymatic digestion

Each multistep protocol can be adapted to our tools and then built and optimized on a breadboard platform into a robust, computer-controlled device that can perform the gamut of routine bioanalytical sample-preparation operations.

### Unique refillable cartridges

At the heart of MAPS are refillable cartridges that can be packed with any type of material in volumes of 1–2000  $\mu\text{L}$ .

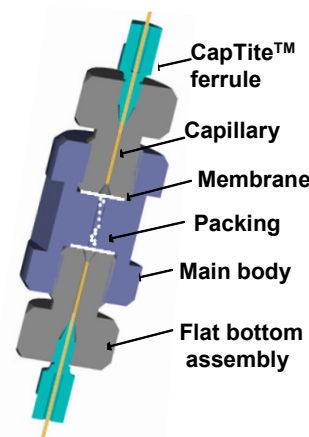


Sandia-designed microfittings, manifolds, pumps, valves, and cartridges can be easily reconfigured to customize sample processing as needed.

A 10- $\mu\text{m}$  membrane confines the packed material, and a kit of inserts offers interchangeable internal volumes and diameter/length ratios to accommodate the requirements of each application.

Capable of being packed with a variety of materials, our refillable cartridges are extremely versatile and are less expensive than commercial alternatives. Our cartridges are also more resistant to clogging because the larger (10- $\mu\text{m}$ ) mesh size of the membrane allows unrestricted passage of particulates.

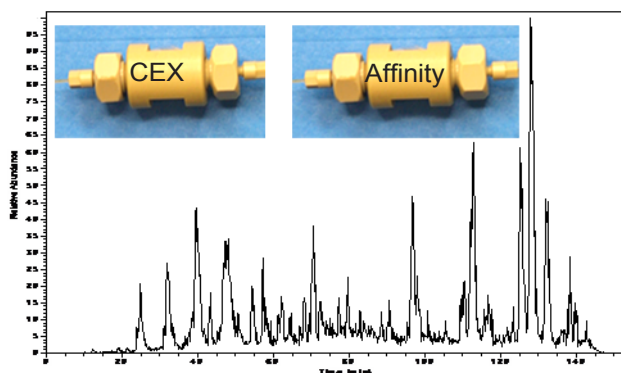
MAPS devices also contain an array of micro-sized Sandia-developed interconnect hardware, including fittings, manifolds, pumps, and valves. Our researchers can configure these hardware elements into kits, which can be mass-produced if desired.



Our refillable cartridge can be easily vacuum-packed with any material, as long as it is larger than the openings in the cartridge's retentive membrane.

## Benefits

- **High throughput.** Multiple processing steps can be automatically performed on any number of samples following a preestablished succession of processing steps.
- **Flexible.** Multidimensional analysis trains can be easily configured to optimize speed and improve information output, and the refillable cartridges can be packed with a variety of reagent materials.
- **Fast.** MAPS reduces sample-preparation time by an order of magnitude.
- **Automatic.** MAPS reduces or eliminates the need for trained technicians and manual preparation steps, as well as the potential for error and sample loss during manual processing.
- **Economical.** The combined effect of multiple elements—smaller, cheaper equipment; automated, faster processing; compatibility with low-pressure, portable systems; and the use of minute amounts of sample and reagents—greatly reduces costs compared to conventional processing.
- **Quality results.** Analysis results are robust and reproducible, even for complex samples such as cell lysates and serum.
- **Compact.** MAPS can be assembled into portable sample-preparation trains about the size of a briefcase.



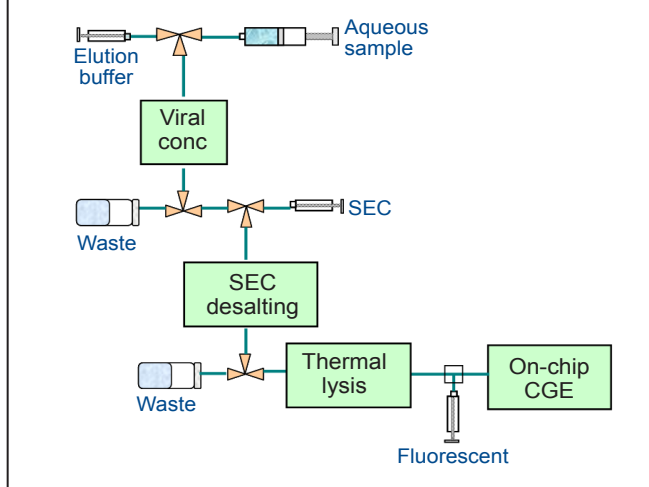
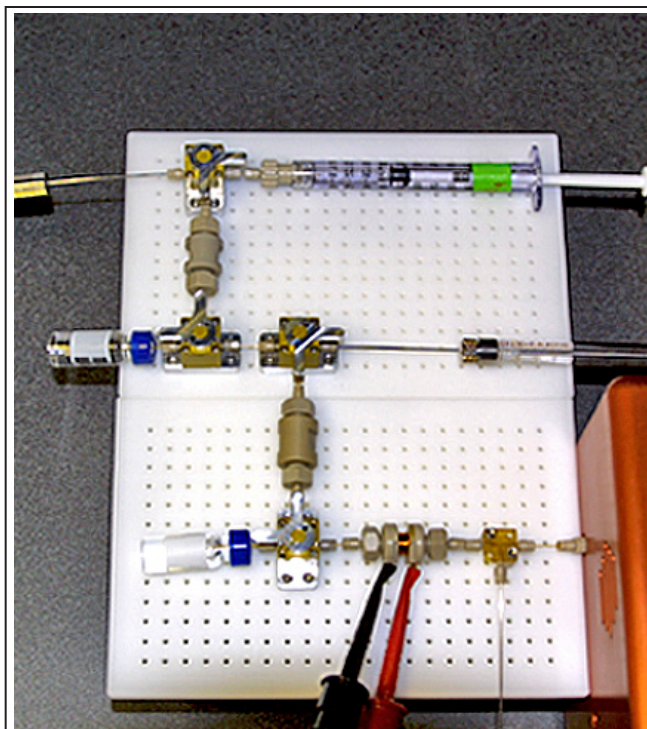
Mass spectrometric analysis of labeled peptides in a lysate of the sulfate-reducing bacteria *Desulfovibrio vulgaris Hildenborough*. The peptides were concentrated and fractionated using cartridges packed with cation-exchange and affinity media.

## Development Status

Sandia has demonstrated automatic-processing modules on a breadboard. We are also investigating the use of MAPS for a variety of applications, including pathogen/host interactions and biomarkers. We are seeking licensees to commercialize kits and/or partners to cofund the development of customized processing kits.

## For More Information

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Multiple processing steps were performed prior to the on-chip analysis. T2 bacteriophages were concentrated, desalted, lysed, and labeled in our system without signal loss.



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